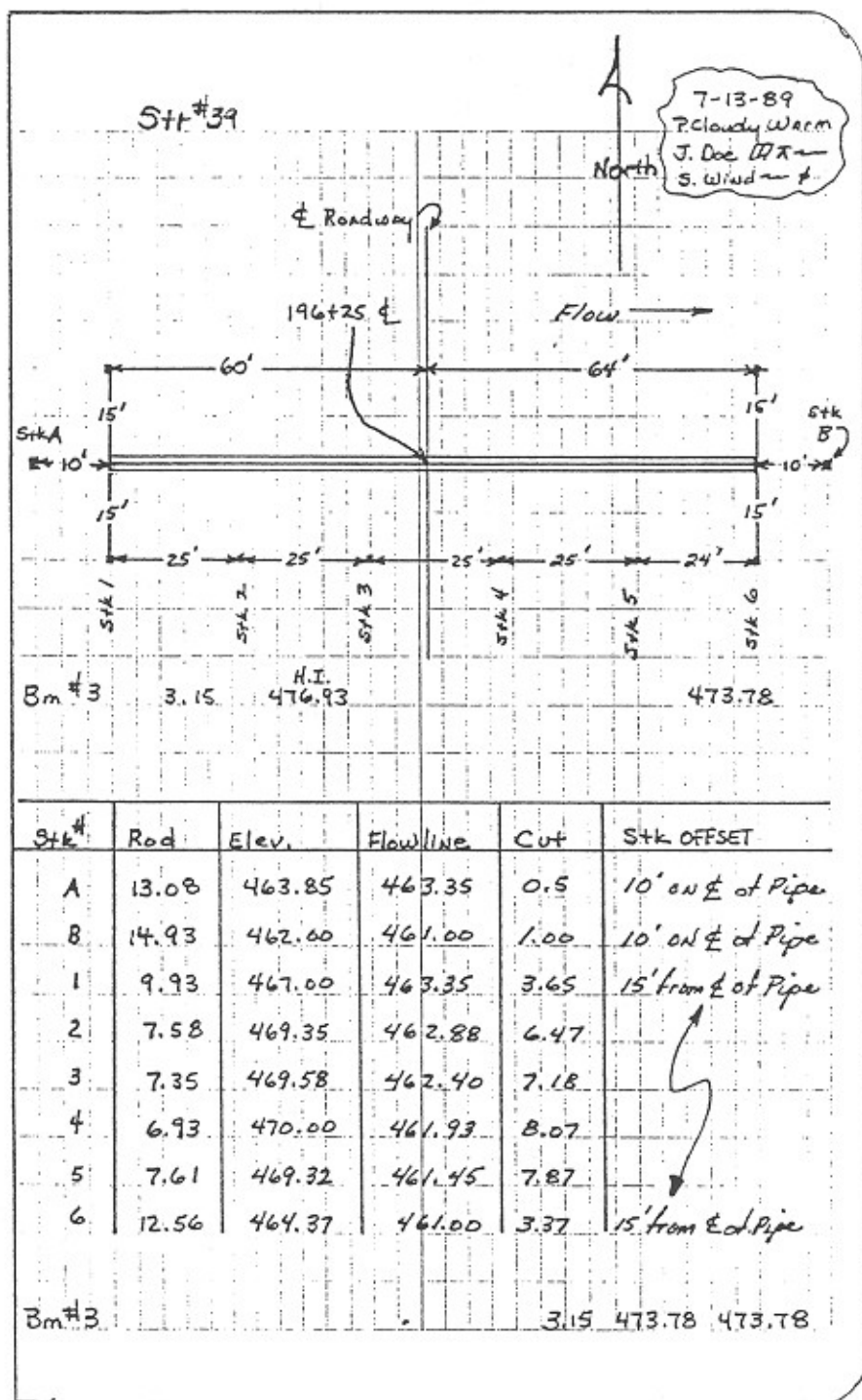


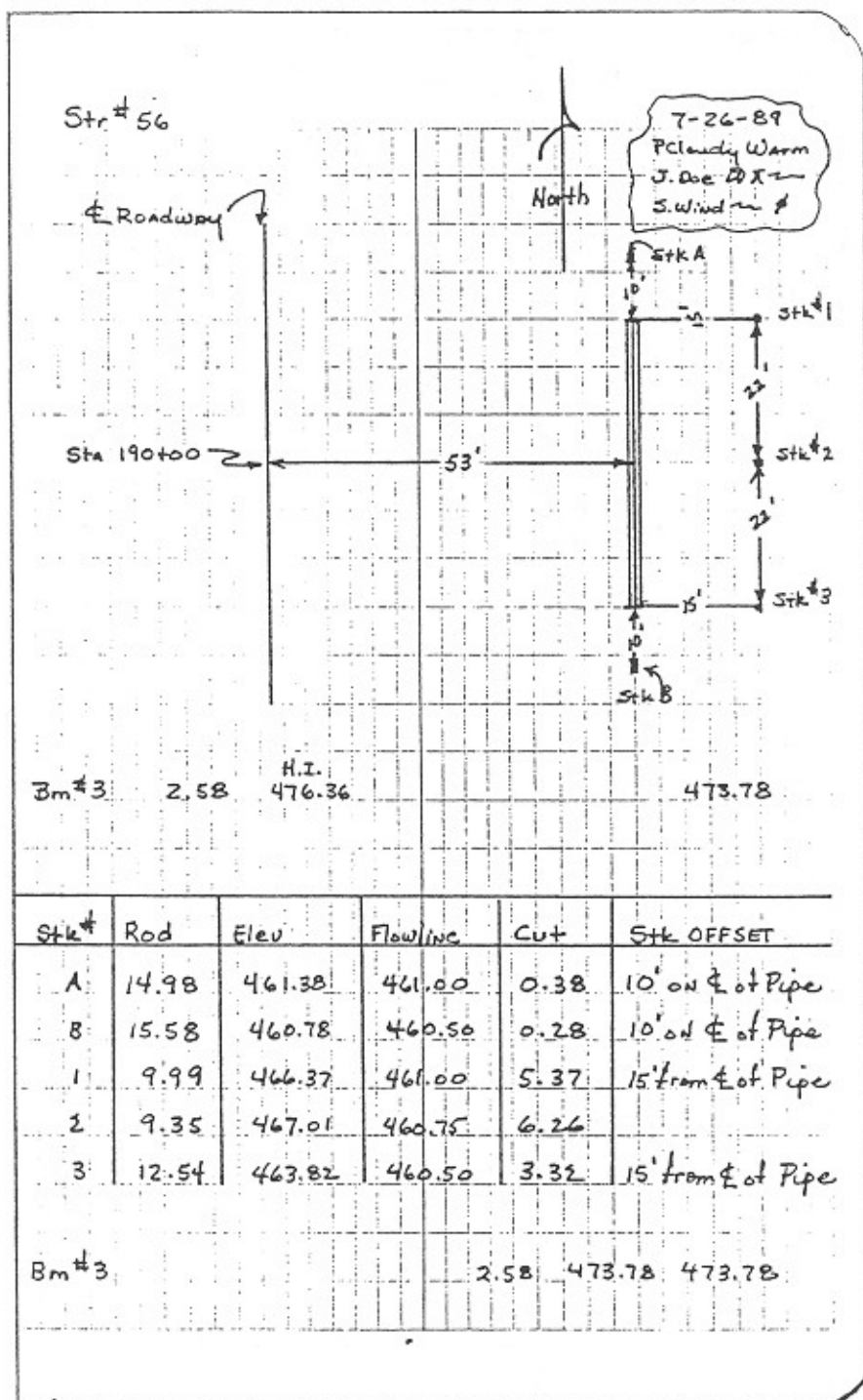
# APPENDIX

* Structure Book Example (Str. # 39) Pipe Perpendicular to roadway	A - 1
* Structure Book Example (Str. # 59) Pipe Parallel to roadway	A - 3
* Sample Lab Report for Pipe (TD - 392)	A - 5
* Sample Lab Report for Reinforced Concrete Pipe	A - 6
* Sample Lab Report for Inlets	A - 7
* Typical Trench Cross Section...Used to determine volume per linear foot of excavation and backfill:	A - 8
* O.S.H.A. General Excavation Requirements	A- 11
* ITM-213-00T FLOWABLE MORTAR TESTS	
* ASTM C-403 FLOWABLE MORTAR TESTS	
* Standard Sheets	

	STR#39				
PLAN					
STATION	196+25				
SIZE	24"				
KIND	F.B.C.C S.				
LENGTH	124'				
F. L.-UP	463.35				
F. L.-DOWN	461.00				
CONC-CL. "D"					
SP. BORROW."B"					
REMARKS:					
	2 pipe end sections required				
PLACED					
STATION					
SKEW					
SIZE					
KIND					
LENGTH					
CONC-CL. "D"					
SP. BORROW "B"					



STR#56					
PLAN					
STATION	190+00-	53'RT			
SIZE	12"				
KIND	F.B.C.C	S.			
LENGTH	44'				
F. L.-UP	461.00				
F. L.-DOWN	460.50				
CONC-CL. "D"					
SP. BORROW."B"					
REMARKS:					
	2 pipe end sections required				
PLACED					
STATION					
SKEW					
SIZE					
KIND					
LENGTH					
CONC-CL. "D"					
SP. BORROW "B"					



CONTRACT / P. O. NUMBER

SOURCE OF MATERIAL **8624** hadoga Culvert Co., hadoga, In  
(NAME OF MANUFACTURER AND LOCATION OF PLANT)

PURPOSE **73** SAMPLED FROM **1** **8657** **2** **(R) Flynn Drainage, Metamora, Ill.**

DATE SAMPLED **07** **26** **89** MO DAY YEAR

MATERIAL CODE	SPECS	LENGTH EACH (1)	SEAL OR YELLOW CARD NO. (2)			NOMINAL DIAMETER OR SPAN X RISE (PIPE ONLY)	SEAM (3)	THICKNESS		HEAT NUMBER	LENGTH TOTAL (4)
			PRE	FROM	TO			SPEC. IFIED	MEAS. URED		
1	8622	88	8	104103	104104	12 in	R	.064	.058	LTV 0417	16
2	8622	88	11	104105	104109	15 in	R	.064	.061	LTV 0417	53
3	8622	88	20	104108	104088	18 in	R	.064	.064	LTV 0417	100
4	8622	88	15	104089	104089	18 in	R	.064	.064	0417	15
5	8622	88	9	104090	104090	18 in	R	.064	.064	0417	9
6	8632	88	6	104091	104091	42 x 29 in	R	.064	.064	0417	6
7	8632	88	21	104092	104092	35 x 24 in	R	.064	.061	0417	21
8	8632	88	9	104093	104093	35 x 24 in	R	.064	.061	0417	9
9											

Fabricated &amp; Coated at Flynn Drainage (8657)

Samples Submitted for Analysis **5-15** **10-18** **1-42+29** **2-35+24** **23'** feetTotal Length Since Last Sampled **23'** feetAnalysis Received **Yes** Samples Met Specifications **Yes** No

Inspected by this report were inspected in accordance with IDOH Specifications, special provisions, and applicable AASHTO Specifications. This inspection verified that have been met.

Signature **Marion Stewart** Signature

STRUCTURAL PLAT PORT TOTAL LENGTH OF STRUCTURE

(3) L - LOCK SEAM R - RIVETED SEAM, W - WELDED SEAM

INDIANA DEPARTMENT OF TRANSPORTATION  
DISTRICT MATERIALS AND TESTS

10-30-89

REPORT ON SAMPLE OF  
REINFORCED CONCRETE PIPE  
CLASS V

LABORATORY NO.	89-C-2419-09481	MATERIAL CODE	852.
SUBMITTED BY	WILSON, MARK A.	DATE SAMPLED	08-05-89
PURPOSE	JOB CONTROL BY OTHER THAN PROJECT PERSONNEL		
SAMPLED FROM	STOCK OR STOCKPILE		
SAMPLED AT	INDEPENDENT CONCRETE PIPE CO. (8524)		
	INDIANAPOLIS, IN. 46200		
QUANTITY REPRESENTED	132 EACH		
SAMPLE MARKING	00132		
SOURCE OF MATERIAL	INDEPENDENT CONCRETE PIPE CO. (8524)		
	INDIANAPOLIS, IN. 46200		
REMARKS	P693339		

\*\*\* TEST RESULTS \*\*\*

NOMINAL DIAMETER OR SPAN, INS.-----	
NOMINAL LENGTH, INS.-----	12
LENGTH (ACTUAL), INS.-----	96.00
WALL THICKNESS MINIMUM, INS.-----	3.25
WALL THICKNESS MAXIMUM, INS.-----	3.25
DEPTH OF SOCKET, INS.-----	3.50
THICKNESS OF SOCKET, INS.-----	2.50
INSIDE DIAMETER OF SOCKET, INS.-----	156.50
INSIDE DIAMETER OF PIPE MIN., INS.-----	12.00
INSIDE DIAMETER OF PIPE MAX., INS.-----	12.00
FIRST CRACK LOAD, LBS/FT-----	4500
10% OVER FIRST CRACK LOAD, LBS/FT-----	
ULTIMATE LOAD, LBS/FT-----	7500
CYLINDER STRENGTH, PSI-----	
OUTER CAGE STEEL AREA, SQ.IN./LFT-----	
INNER CAGE STEEL AREA, SQ.IN./LFT-----	.07
ABSORPTION MAXIMUM, PCT.-----	7.1
COARSE AGGREGATE SOURCE NUMBER-----	2313
FINE AGGREGATE SOURCE NUMBER-----	2313
CEMENT SOURCE NUMBER-----	1

REMARKS:

THIS REPORT FOR CONTRACT R - 17982 IS VALID FOR NO MORE THAN 000002 E OF MATERIAL. IF LESS THAN THIS QUANTITY IS USED, THE PROJECT ENGINEER IS TO REPORT THE UNUSED AMOUNT TO THE DIVISION OF MATERIALS AND TESTS ON FORM TD-527.

*Kenneth R. Hoover*

COPIES TO:  
DISTRICT ENGINEER D. HUYETT  
PROJECT ENGINEER T. SPESARD  
FILE

CHIEF, DIVISION OF MATERIALS AND TESTS



INDIANA DEPARTMENT OF TRANSPORTATION  
DISTRICT MATERIALS AND TESTS

11-28-89

REPORT ON SAMPLE OF  
MANHOLE, INLET, OR CATCH BASIN  
COMPONENT ITEM

LABORATORY NO.	89-0-2657-04492	MATERIAL CODE	8795
SUBMITTED BY	PEPMEIER, JOHN	DATE SAMPLED	10-11-89
PURPOSE	JOB CONTROL BY OTHER THAN PROJECT PERSONNEL		
SAMPLED FROM	STOCK OR STOCKPILE		
SAMPLED AT	WASHINGTON CONCRETE CO. INC. (8540) 611 WEST MAIN STREET WASHINGTON, IN. 47501		
QUANTITY REPRESENTED	9 EACH		
SAMPLE MARKING			
SOURCE OF MATERIAL	WASHINGTON CONCRETE CO. INC. (8540) 611 WEST MAIN STREET WASHINGTON, IN. 47501		
REMARKS	P896439		

\*\*\* TEST RESULTS \*\*\*

NUMBER OF BASE SECTIONS-----	
NUMBER OF RISER OR BARREL SECTIONS-----	
NUMBER OF CONE SECTIONS-----	
NUMBER OF FLAT TOPS-----	
NUMBER OF INLETS-----	9
CEMENT TYPE-----	
CEMENT PRODUCER-----	1
FINE AGGREGATE SIZE, TYPE-----	
FINE AGGREGATE PRODUCER-----	2657
COARSE AGGREGATE SIZE, TYPE-----	
COARSE AGGREGATE PRODUCER-----	2645
REINFORCING STEEL TYPE-----	
REINFORCING STEEL PRODUCER-----	
NUMBER OF ABSORPTION TESTS-----	2
MAXIMUM ABSORPTION, PCT-----	7.0
NUMBER OF COMPRESSIVE STRENGTH TESTS-----	2
MINIMUM COMPRESSIVE STRENGTH, PSI-----	4386
AVERAGE COMPRESSIVE STRENGTH, PSI-----	
NUMBER OF DIMENSION CHECKS-----	
NUMBER OF PIECES ACCEPTED-----	9
NUMBER OF PIECES REJECTED-----	

REMARKS:

THIS REPORT FOR CONTRACT R - 17982 IS VALID FOR NO MORE  
THAN 000001 E OF MATERIAL. IF LESS THAN THIS QUANTITY  
IS USED, THE PROJECT ENGINEER IS TO REPORT THE UNUSED  
AMOUNT TO THE DIVISION OF MATERIALS AND TESTS ON FORM TD-527.

*Kenneth R. Hoover*



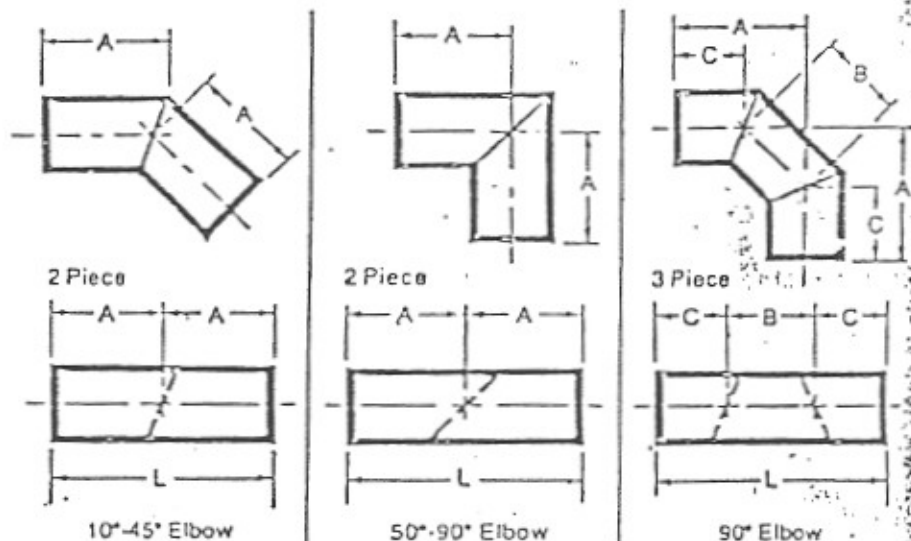
# ATLANTIC AREA

17A

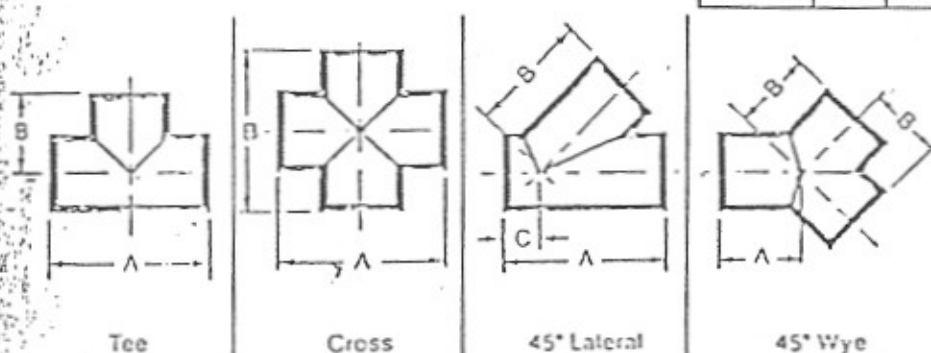
Minimum Dimensions for CSP Round Fittings,  
All Corrugations

NOTE: 1. Actual dimensions may vary to suit special situations.

Shipment of large fittings is contingent upon highway dimensional clearances. Permit information must be cleared before order confirmation.



Diameter	A	L	Diameter	A	L	Diameter	A	B	C	L
inches	feet	feet	inches	feet	feet	inches	inches			feet
6-10	1	2	6-10	1	2	6	1	1	1	3
12-16	2	4	12-27	2	4	8	1	1	1	3
24-36	3	6	30-42	3	6	10	2	2	2	6
			48-66	4	8	12	2	2	2	6
			72-84	5	10	15				
			90-96	6	12	18				
						21				
						24				
						27				
						30				
						33				
						36				
						42				
						48	32	32	32	12
						54				
						60				
						66				
						72	40	40	40	12
						78				
						84				
						90				
						96	48	48	48	12



Stub Diameter Same as Main or less  
Tables and figures Same Diameters

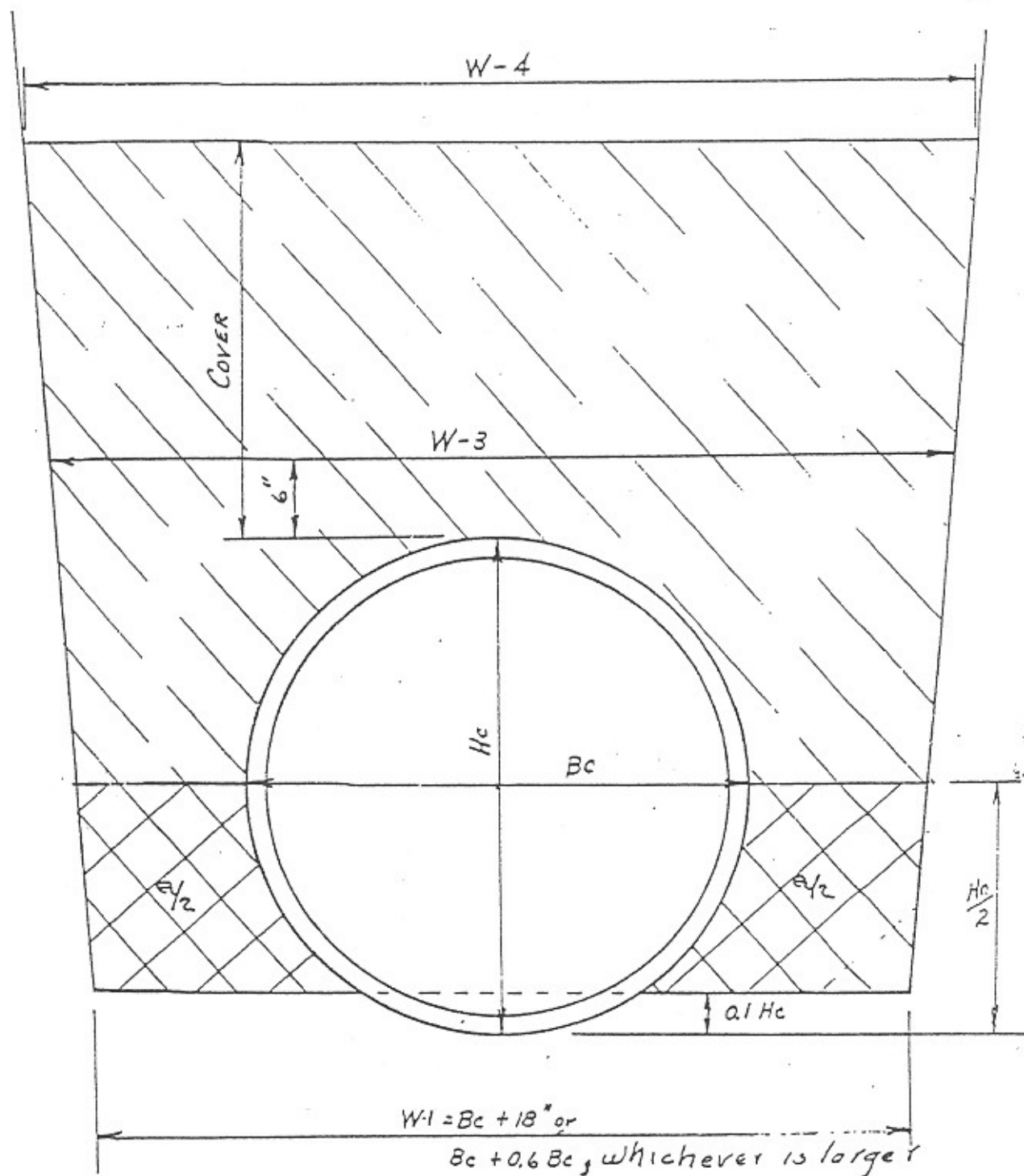
L = Linear Feet Pipe to Make Fitting

Diameter	Tee			Cross			45° Lateral				45° Wye		
	A	B	L	A	B	L	A	B	C	L	A	B	L
	feet			feet			feet		inches	feet	feet		
6	2	1	3	2	2	4	2	2	8	4	2	2	6
8	2	1	3	2	2	4	2	2	8	4	2	2	6
10	2	1	3	2	2	4	4	1	17	6			
12	4	2	6	4	4	8		2	17	6			
15		2	6					4	18	8			
18							4		13	8			
21							6		22	10			
24									23				
27									20				
30	4	2	6	4	4	8		4	21	10	2	2	6
33	6	4	10	6	6	12	6	6	19	12	2	3	8
36							8	6	19	14			
42							8	6	21	14			
48							10	8	28	18	2	3	8
54	6		10	6	6	12	10	8	23	18	4	4	12

L = Linear Feet of CSP Required  
to Fabricate Fitting

Note: All Dimensions Nominal

# CIRCULAR PIPE



CROSS SECTION OF TRENCH  
FOR WHICH  
VOLUMES PER LINEAL FOOT ARE TABULATED

In the following table headings, (A) is equal to the volume of the double cross hatched area for each lineal foot of pipe.

[USE WITH CROSS SECTION OF TRENCH  
ON A-16]

TABLE 005

30 IN. C. M. PIPE

W-3= 4.458

A= .0698

COVER FEET	W-4 FEET	CUBIC YARDS PER/PIPE/LFT
0.6	4.475	0.2749
0.8	4.508	0.3082
1.0	4.541	0.3417
1.2	4.575	0.3755
1.4	4.608	0.4095
1.6	4.641	0.4438
1.8	4.675	0.4783
2.0	4.708	0.5130
2.2	4.741	0.5480
2.4	4.775	0.5833
2.6	4.808	0.6188
2.8	4.841	0.6545
3.0	4.875	0.6905
3.2	4.908	0.7267
3.4	4.941	0.7632
3.6	4.975	0.7999
3.8	5.008	0.8369
4.0	5.041	0.8741
4.2	5.075	0.9116
4.4	5.108	0.9493
4.6	5.141	0.9873
4.8	5.175	1.0255
5.0	5.208	1.0640
5.2	5.241	1.1027
5.4	5.275	1.1416
5.6	5.308	1.1808
5.8	5.342	1.2203
6.0	5.375	1.2599
6.2	5.408	1.2999
6.4	5.442	1.3401
6.6	5.475	1.3805
6.8	5.508	1.4212
7.0	5.542	1.4621
7.2	5.575	1.5033
7.4	5.608	1.5447
7.6	5.642	1.5864
7.8	5.675	1.6283
8.0	5.708	1.6704
8.2	5.742	1.7129
8.4	5.775	1.7555
8.6	5.808	1.7984
8.8	5.842	1.8416
9.0	5.875	1.8850
9.2	5.908	1.9286
9.4	5.942	1.9725
9.6	5.975	2.0166
9.8	6.008	2.0610

TABLE 006

36 IN. C. M. PIPE

W-3= 5.333

A= .1005

COVER FEET	W-4 FEET	CUBIC YARDS PER/PIPE/LFT
0.6	5.350	0.3721
0.8	5.383	0.4118
1.0	5.416	0.4518
1.2	5.450	0.4921
1.4	5.483	0.5326
1.6	5.516	0.5733
1.8	5.550	0.6143
2.0	5.583	0.6555
2.2	5.616	0.6970
2.4	5.650	0.7387
2.6	5.683	0.7807
2.8	5.716	0.8229
3.0	5.750	0.8654
3.2	5.783	0.9081
3.4	5.816	0.9511
3.6	5.850	0.9943
3.8	5.883	1.0378
4.0	5.916	1.0815
4.2	5.950	1.1254
4.4	5.983	1.1696
4.6	6.016	1.2141
4.8	6.050	1.2587
5.0	6.083	1.3037
5.2	6.116	1.3489
5.4	6.150	1.3943
5.6	6.183	1.4400
5.8	6.217	1.4859
6.0	6.250	1.5321
6.2	6.283	1.5785
6.4	6.317	1.6252
6.6	6.350	1.6721
6.8	6.383	1.7192
7.0	6.417	1.7667
7.2	6.450	1.8143
7.4	6.483	1.8622
7.6	6.517	1.9104
7.8	6.550	1.9588
8.0	6.583	2.0074
8.2	6.617	2.0563
8.4	6.650	2.1054
8.6	6.683	2.1548
8.8	6.717	2.2044
9.0	6.750	2.2543
9.2	6.783	2.3044
9.4	6.817	2.3548
9.6	6.850	2.4054
9.8	6.883	2.4563

## SUBPART P—EXCAVATIONS, TRENCHING, AND SHORING

### 1926.650—GENERAL PROTECTION REQUIREMENTS

(a) Walkways, runways, and sidewalks shall be kept clear of excavated material or other obstructions and no sidewalks shall be undermined unless shored to carry a minimum live load of one hundred and twenty-five (125) pounds per square foot.

(b) If planks are used for raised walkways, runways, or sidewalks, they shall be laid parallel to the length of the walk and fastened together against displacement.

(c) Planks shall be uniform in thickness and all exposed ends shall be provided with beveled cleats to prevent tripping.

(d) Raised walkways, runways, and sidewalks shall be provided with plank steps on strong stringers. Ramps, used in lieu of steps, shall be provided with cleats to insure a safe walking surface.

(e) All employees shall be protected with personal protective equipment for the protection of the head, eyes, respiratory organs, hands, feet, and other parts of the body as

set forth in Subpart E of this part.

(f) Employees exposed to vehicular traffic shall be provided with and shall be instructed to wear warning vests marked with or made of reflectorized or high visibility material.

(g) Employees subjected to hazardous dusts, gases, fumes, mists, or atmospheres deficient in oxygen, shall be protected with approved respiratory protection as set forth in Subpart D of this part.

(h) No person shall be permitted under loads handled by power shovels, derricks, or hoists. To avoid any spillage employees shall be required to stand away from any vehicle being loaded.

(i) Daily inspections of excavations shall be made by a competent person. If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions have been taken to safeguard the employees.

### 1926.651—SPECIFIC EXCAVATION REQUIREMENTS

(a) Prior to opening an excavation, effort shall be made to determine whether underground installations; i.e., sewer, telephone, water, fuel, electric lines, etc., will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.

(b) Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work

or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.

(c) The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or some other equivalent means.

(d) Excavations shall be inspected by a competent person after every rainstorm or other hazard-increasing occurrence, and the protection against slides and cave-ins shall be increased if necessary.

(e) The determination of the angle of repose

and design of the supporting system shall be based on careful evaluation of pertinent factors such as: Depth or cut; possible variation in water content of the material while the excavation is open; anticipated changes in materials from exposure to air, sun, water, or freezing; loading imposed by structures, equipment, overlying material, or stored material; and vibration from equipment, blasting, traffic, or other sources.

(f) Supporting systems; i.e., piling, cribbing, shoring, etc., shall be designed by a qualified person and meet accepted engineering requirements. When tie rods are used to restrain the top of sheeting or other retaining systems, the rods shall be securely anchored well back of the angle of repose. When tight sheeting or sheet piling is used, full loading due to ground water table shall be assumed, unless prevented by weep holes or drains or other means. Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.

(g) All slopes shall be excavated to at least the angle of repose except for areas where solid rock allows for line drilling or pre-splitting.

(h) The angle of repose shall be flattened when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.

(i)

(1) In excavations which employees may be required to enter, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation.

(2) As an alternative to the clearance prescribed in subparagraph (1) of this paragraph, the employer may use effective barriers or other effective retaining devices in lieu thereof in order to prevent excavated or other materials from falling into the excavation.

(j) Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, benching, barricading, rock bolting, wire meshing, or other equally effective means. Special attention shall be given to slopes which may be adversely affected by weather or moisture content.

(k) Support systems shall be planned and designed by a qualified person when excavation is in excess of 20 feet in depth, adjacent to structures or improvements, or subject to vibration or ground water.

(l) Materials use for sheeting, sheet piling, cribbing, bracing, shoring, and underpinning shall be in good serviceable condition, and timbers shall be sound, free from large or loose knots, and of proper dimensions.

(m) Special precautions shall be taken in sloping or shoring the sides of excavations adjacent to a previously backfilled excavation or a fill, particularly when the separation is less than the depth of the excavation. Particular attention also shall be paid to joints and seams of material comprising a face and the slope of such seams and joints.

(n) Except in hard rock, excavations below the level of the base of footing of any foundation or retaining wall shall not be permitted, unless the wall is underpinned and all other precautions taken to insure the stability of the adjacent walls for the protection of employees involved in excavation work or in the vicinity thereof.

(o) If the stability of adjoining buildings or walls is endangered by excavations, shoring, bracing, or underpinning shall be provided as necessary to insure their safety. Such shoring, bracing, or underpinning shall be inspected daily or more often, as conditions warrant, by a competent person and the protection effectively maintained.

(p) Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to



accumulate in an excavation.

(q) If it is necessary to place or operate power shovels, derricks, trucks, materials, or other heavy objects on a level above and near an excavation, the side of the excavation shall be sheet-piled, shored, and braced as necessary to resist the extra pressure due to such superimposed loads.

(r) Blasting and the use of explosives shall be performed in accordance with Subpart U of this part.

(s) When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed. If possible, the grade should be away from the excavation.

(t) Adequate barrier physical protection shall be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.

(u) If possible, dust conditions shall be kept to a minimum by the use of water, salt, calcium chloride, oil, or other means.

(v) In locations where oxygen deficiency or gaseous conditions are possible, air in the excavation shall be tested. Controls, as set forth in Subparts D and E of this part, shall be established to assure acceptable atmospheric conditions. When flammable gases are present, adequate ventilation shall be provided or sources of ignition shall be eliminated. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, basket stretcher, etc., shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.

(w) Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.

(x) Where ramps are used for employees or equipment, they shall be designed and constructed by qualified persons in accordance with accepted engineering requirements.

(y) All ladders used on excavation operations shall be in accordance with the requirements of Subpart L of this part.

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## 1926.652—SPECIFIC TRENCHING REQUIREMENTS

---

(a) Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to Table P-1 as a guide in sloping of banks. Trenches less than 5 feet in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.

(b) Sides of trenches in unstable or soft material, 5 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them. See Tables P-1, P-2 (following paragraph (g) of this section).

(c) Sides of trenches in hard or compact soil, including embankments, shall be shored or otherwise supported when the trench is more than 5 feet in depth and 8 feet or more in length. In lieu of shoring, the sides of the trench above the 5-foot level may be sloped to preclude collapse, but shall not be steeper than a 1-foot rise to each  $\frac{1}{2}$ -foot horizontal. When the outside diameter of a pipe is greater than 6 feet, a bench of 4-foot minimum shall be provided at the toe of the sloped portion.

(d) Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed

and installed so as to be effective to the bottom of the excavation.

(e) Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.

(f) Employees entering bell-bottom pier holes shall be protected by the installation of a removeable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove

materials excavated from the bell footing.

(g)

(1) Minimum requirements for trench timbering shall be in accordance with Table P-2.

(2) Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stress in excess of values given by the following formula:

$$S = 1300 - \frac{20L}{D}$$

$$\text{Maximum ratio } \frac{L}{D} = 50$$

Where:

$L$  = Length, unsupported, in inches.

$D$  = Least side of the timber in inches.

$S$  = Allowable stress in pounds per square inch of cross-section.

Table P - 1

### APPROXIMATE ANGLE OF REPOSE FOR SLOPING OF SIDES OF EXCAVATIONS

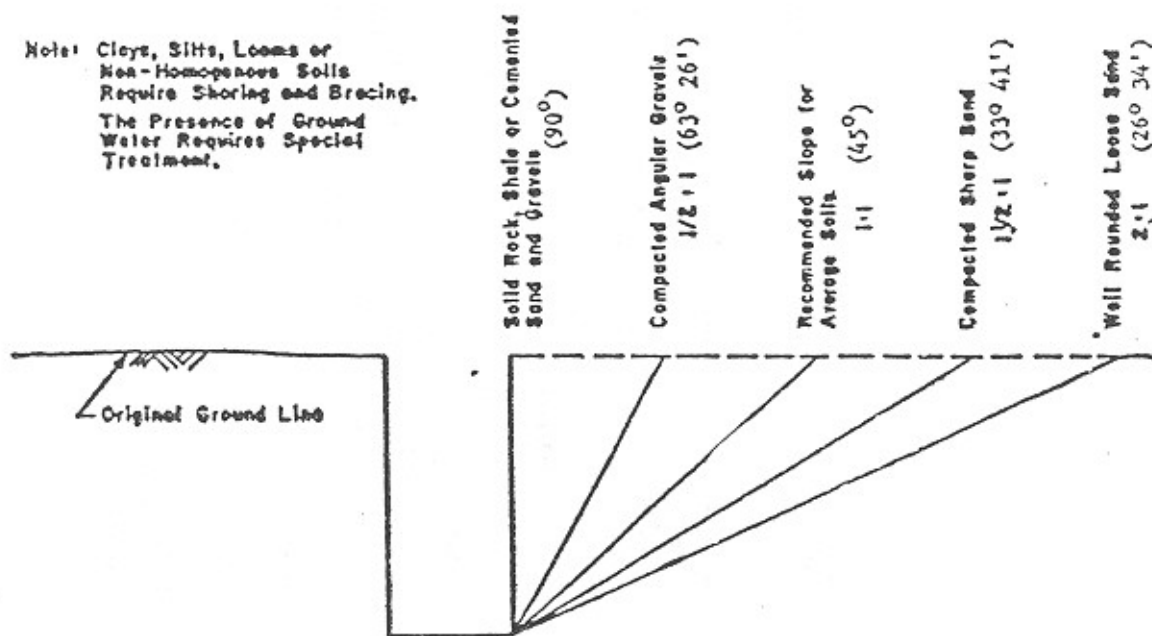




TABLE P-2  
TRENCH SHORING—MINIMUM REQUIREMENTS

Depth of trench	Kind or condition of earth	Size and spacing of members											
		Uprights		Stringers		Cross braces <sup>1</sup>						Maximum spacing	
		Minimum dimension	Maximum spacing	Minimum dimension	Maximum spacing	Up to 3 feet	3 to 6 feet	6 to 9 feet	9 to 12 feet	12 to 15 feet	Vertical	Horizontal	
Feet		Inches	Feet	Inches	Feet	Inches	Inches	Inches	Inches	Inches	Feet	Feet	Feet
3 to 10	Hard, compact.....	3 x 4 or 2 x 6	6	.....	.....	2 x 6	4 x 4	4 x 6	6 x 6	6 x 8	4	4	6
	Likely to crack.....	3 x 4 or 2 x 6	3	4 x 6	4	2 x 6	4 x 4	4 x 6	6 x 6	6 x 8	4	4	6
	Soft, sandy, or filled.....	3 x 4 or 2 x 6	Close sheathing	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	4	6
	Hydrostatic pressure.....	3 x 4 or 2 x 6	Close sheathing	6 x 8	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	4	6
10 to 15	Hard.....	3 x 4 or 2 x 6	4	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	4	6
	Likely to crack.....	3 x 4 or 2 x 6	2	4 x 6	4	4 x 4	4 x 6	6 x 6	6 x 8	8 x 8	4	4	6
	Soft, sandy, or filled.....	3 x 4 or 2 x 6	Close sheathing	4 x 6	4	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10	4	4	6
	Hydrostatic pressure.....	3 x 6	Close sheathing	8 x 10	4	4 x 6	6 x 6	6 x 8	8 x 8	8 x 10	4	4	6
15 to 20	All kinds or conditions.....	3 x 6	Close sheathing	4 x 12	4	4 x 12	6 x 8	8 x 8	8 x 10	10 x 10	4	4	6
Over 20	All kinds or conditions.....	3 x 6	Close sheathing	6 x 8	4	4 x 12	8 x 8	8 x 10	10 x 10	10 x 12	4	4	6

<sup>1</sup> Trench jacks may be used in lieu of, or in combination with, cross braces. Shoring is not required in solid rock, hard shale, or hard slag. Where desirable, steel sheet piling and bracing of equal strength may be substituted for wood.

(h) When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps, shall be provided and located so as to require no more than 25 feet of lateral travel.

(i) Bracing or shoring of trenches shall be carried along with the excavation.

(j) Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling, or kickouts.

(k) Portable trench boxes or sliding trench

shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench.

(l) Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

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## 1926.653—DEFINITIONS APPLICABLE TO THIS SUBPART

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(a) "Accepted engineering requirements (or practices)"—Those requirements or practices which are compatible with standards required by a registered architect, a registered professional engineer, or other duly licensed or recognized authority.

(b) "Angle of repose"—The greatest angle above the horizontal plane at which a material will lie without sliding.

(c) "Bank"—A mass of soil rising above a digging level.

(d) "Belled excavation"—A part of a shaft or footing excavation, usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.

(e) "Braces (trench)"—The horizontal members of the shoring system whose ends bear against the uprights or stringers.

(f) "Excavation"—Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce

the depth-to-width relationship, an excavation may become a trench.

(g) "Faces"—See paragraph (k) of this section.

(h) "Hard compact soil"—All earth materials not classified as running or unstable.

(i) "Kickouts"—Accidental release or failure of a shore or brace.

(j) "Sheet pile"—A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.

(k) "Sides," "Walls," or "Faces"—The vertical or inclined earth surfaces formed as a result of excavation work.

(l) "Slope"—The angle with the horizontal at which a particular earth material will stand indefinitely without movement.

(m) "Stringers" (wales)—The horizontal members of a shoring system whose sides bear against the uprights or earth.

(n) "Trench"—A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.

(o) "Trench jack"—Screw or hydraulic type jacks used as cross bracing in a trench shoring system.

(p) "Trench shield"—A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.

(q) "Unstable soil"—Earth material, other than running, that because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.

(r) "Uprights"—The vertical members of a shoring system.

(s) "Wales"—See paragraph (m) of this section.

(t) "Walls"—See paragraph (k) of this section.